ISSN: 2581-3404 (Online)
International Journal of Innovative Research in Technology and Management, Vol-5, Issue-5, 2021.

Spectrum Sensing in Cognitive Radio Network: Survey and Discussions

Neha Kapse[1], Prof. Jitendra Mishra[2]

[1]M. Tech. Scholar, Department of EC, PCST, Bhopal (India)

[2]Head & Professor, Department of EC, PCST, Bhopal (India)

Abstract-*The advent of new applications and technologies such as the Internet of Things, Cyber-Physical Systems, etc., has propelled the demand for wireless spectrum [1]. This increase in demand for spectrum cannot be achieved easily as a spectrum is a limited resource, and its expansion is difficult due to technological limitations. Cognitive radio is a promising technology which allows secondary users (SUs) to access the licensed band of primary user (PU) opportunistically when it is not being used by the primary user. Thus, the transmission of the PU is not impacted in any way. In this paper we review the different techniques in cognitive radio for the spectrum sharing, in future try to enhance the utilization of unused channel and frequency for secondary user.*

Keywords:- Cognitive radio, Deep learning, spectrum sensing, Convolutional neural network.

INRODUCTION

The radio spectrum is the unique natural resource totally assigned to different licensed holders according to the fixed spectrum assignment policy. It was then analyzed that a large portion of spectrum is not utilized under time and place. Cognitive radio (CR) was proposed to solve this problem by opportunistically utilizing the spectrum during the absence of their owners. It was considered to play a major role for the under-utilization of spectrum resources to meet the continuous greatest demand of wireless systems. Cognitive radio networks (CRNs) enable cognitive users (or secondary users) to sense the environment in order to identify spectrum holes, analyse the parameters, and make decisions for dynamic resource allocation management. These capabilities are realized through integrating artificial intelligence (AI) techniques in the heart of the CR. AI enables cognitive users to solve problems by emulating human biological processes such as learning, reasoning, decision making, self-adaptation, self-organization, and self-stability.

CR was firstly defined by Joseph Mitola as “a radio that is aware of its surroundings and adapts intelligently”. It has been introduced to respond to the under-utilization of spectral resources by dynamically access the temporarily unused spectrum bands. CRNs bring new cognitive radio users (CRUs) that should sense the licensed bands to identify the spectrum holes, and then exploit them as long as they don’t interfere with the licensed users. To meet these capabilities, CRN executes the four main functions of the cognitive cycle. These functions are: spectrum sensing, spectrum management, spectrum sharing, and spectrum mobility.

Spectrum sensing is an important function in CRNs using dynamic spectrum access. The CRU must identify available bands for its transmission and be able to detect the presence of the primary users (PUs) in order to avoid harmful interferences. Spectrum sensing can be done by one or multiple CRUs exchanging information in cooperative way or in competitive manner. Generally exist three spectrum sensing strategies

includes transmitter-based sensing method, interference temperature-based sensing method or through the received Signal-to-Noise Ratio (SNR). Spectrum management decides and allocates the best available spectrum band among available bands to meet theuser transmission requirements and improve his throughput. Spectrum sharing coordinates access among SUs and share available spectrum bands between them in fair manner. Spectrum sharing techniques can be classified as interweave, underlay, and overlay.

II RELATED WORK

[1] Aravind Narayanan Krishnamoorthy, Arun Shivaram Pasupathy, Maheshkumar Mani, Santhoshkumar Krishnamurthi, Sathiesh Kumar Leelakrishnan, Kotheneth Achuthan Narayanankutty, "Optimization of Threshold for Energy Based Spectrum Sensing Using Differential Evolution", Wireless Engineering and Technology, 2011, 2, 130-134 , doi:10.4236/wet.2011.23019 Published Online July 2011, In this paper, we have first explained the sensing problem involved, the requirement of optimization and the objective functions. We have then stated the disadvantage of generic algorithms in these circumstances, which is the large number of iterations it takes to converge. We then propose a method for non-convex threshold optimization using differential evolution and then compare the results obtained from differential evolution and genetic algorithms. Based on three factors, namely the number of function evaluations, the marginal increase in the throughput achieved and the easiness of localizing the best solution, we conclude that differential evolution has certain definite advantages over genetic algorithms in optimizing the threshold for energy based spectrum sensing.

[2] R Kaniezhil, "Improvement in Utilization of the Spectrum using Cognitive Radio nodes", International Journal of Computational Intelligence and Informatics, Vol. 4: No. 2, July – September 2014, This paper provides how ways of spectrum utilization and implementation varies from researchers to researchers. The main objective of the paper is to improve the overall spectral efficiency by sharing the spectrum among the service providers and avoiding the spectrum scarcity. The proposed system validates the utilization of spectrum sharing in three different ways like Normal utilization, applying Fuzzy logic system and predicting traffic pattern and finally proves that utilization of the spectrum has been improved with reduced call blockage, reduced interference and reduced high traffic patterns of the calls. This paper also gives the study of Spectrum sharing with different technologies.

[3] Mandeep Kaur,Amandeep Kaur, "Cognitive Radio Spectrum Sharing Techniques : A Review", (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (3) , 2015, In this paper authors have reviewed different spectrum sharing technique available in literature. Cognitive radio is one of the methods to utilized the spectrum efficiently and key element of cognitive radio is spectrum sharing . The spectrum will be efficiently used and available for a person in need. Spectrum sharing is used for share the spectrums. If any channel(licensed channel) is free then another channel (unlicensed channel) can access the free channels.

[4] Jamal Elhachmi and Zouhair Guennoun,"Cognitive radio spectrum allocation using genetic algorithm", Elhachmi and Guennoun EURASIP Journal on Wireless Communications and Networking (2016), In this paper, authors have adopted a suitable mathematical formulation for opportunistic channel allocation. While taking into account spectrum dynamicity, we propose a genetic algorithm for channel assignment problem in cognitive radio and we give the steps of its implementation. The GA is based on the new enhanced crossover and mutation operators. It has a uniform distribution compared to the classical genetic algorithm, since it is oriented to explore promising solutions in the search space. Experimental results show the validity of this approach. It cannot only find good solutions to the radio channel allocation problem but also obtain the optimal solution in a reasonably short

execution time, with high quality solutions and better than those of the best current approaches used in node-link-based and optimal algorithm. It promotes the real-time allocation of cognitive radio spectrum.

[5] Roopali Garg, Nitin Saluja,"Spectrum Sensing in Cognitive Radio: Components and Methodologies", Proceedings of the World Congress on Engineering and Computer Science 2016 Vol I WCECS 2016, October 19-21, 2016, This paper describes the various dimensions of radio spectrum space, the hardware challenges associated and the various concerns associated with the domain. Cooperative sensing overcomes the problem of shadowing, fading, noise uncertainty and hidden primary user problem. Also, a detailed discussion and comparison of various spectrum sensing techniques is presented. These techniques can be categorized as blind detection methods and methods having prior knowledge.

[6] Roopali Garg, Dr. Nitin Saluja, " Current Trends and Research Challenges in Spectrum Sensing for Cognitive Radios", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 7, No. 7, 2016, This paper reviews the current trends in research in the domain of spectrum sensing. The author describes the type of channel being modelled, diversity combining schemes used, optimal algorithms applied at fusion centre, spectrum sensing techniques employed. Further, the research challenges are discussed. It is resented that various attributes like sensing time, throughput, rate reliability, optimum cooperative users, sensing frequency etc. needs to be addressed. A trade-off needs to be established to optimize two opposing parameters like sensing and throughput.

[7] Wei Liang, Soon Xin Ng,Lajos Hanzo, "Cooperative Overlay Spectrum Access in Cognitive Radio Networks", IEEE Communications Surveys & Tutorials, Vol. 19, 2017, Authors have investigated the cooperative relaying technique in the context of the overlay spectrum access scheme aiming for allowing the PUs to transmit at a lower power and/or at a higher throughput, while at the same time enabling the CUs to communicate using the bandwidth released. Additionally, gaming techniques can be employed for negotiating between the PUs and the CUs for determining the specific fraction of relaying and active transmission time. Therefore, we will consider two main schemes in the overlay spectrum access scheme based on the CCR network, which are the frequency division-based channel as well as the time-division based channel. Moreover, we have surveyed the relevant advances concerning the game-based model of the overlay-based CR network. Specifically, both the family of non-cooperative and cooperative games as well as matching games have been reviewed. Furthermore, we will review the joint design of coding, modulation, user-cooperation, and CCR techniques, which leads to significant mutual benefits for both the PUs and CUs.

[8] J. Divya lakshmi, Rangaiah. L,"Cognitive Radio Principles and Spectrum Sensing",International Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249 – 8958, Volume-8 Issue-6, August 2019, This paper details the sensing and interference mechanisms of the cognitive radio and explains how and why the cognitive setup is far excellent compared to the conventional radios. There are numerous technologies used in the cognitive radio setup such as the Adaptive radio and Software Defined Radio (SDR). The applications of the findings of this paper can be extended to cognitive radio design and implementation.

[9] L.Rajesh, M Sivaranjini, "Machine Learning Techniques Based Spectrum Sensing In Crn,International Journal of Scientific & Technology Research Volume 8, Issue 11, November 2019, In this paper,authors have investigate the hidden primary user problem and it is solved using the machine learning based cooperative spectrum sensing in cognitive radio networks. It is verified that hidden primary user causes overlap of data distribution which causes

the secondary user misclassify the spectrum occupancy. Experimental results shows that the hidden primary user can be found by using the machine learning based cooperative spectrum sensing .

[10] M. Mourad Mabrook, Hussein A. Khalil , Aziza I. Hussein , "Artificial Intelligence Based Cooperative Spectrum Sensing Algorithm for Cognitive Radio Networks", Science Direct, Procedia Computer Science 163 (2019), In this paper adaptive blind Multi-Coset sampling based wide spectrum sensing technique is used In order to overcome the effect of noise and fading problems, centralized cooperative sensing scheme is developed. The proposed system consists of five SUs each user utilize adaptive MC algorithm to detect the free channels then, centralized cooperative sensing scheme is applied to collect the detection results of each user. After that, AI detecting technique based on ANFIS structure is implemented including five inputs and fifteen rules. The channel power levels PMU was calculated for ANFIS detected channels and it was the highest among others over five senders. The error was theoritically calculated about 10% but practical wise was 1 % after 300 epoch of training. Simulation results proved that the proposed cooperative model based on ANFIS detection is a perfect detection system compared to other common conventional detection rules.

[11] Mohamed El-Tarhuni, Khaled Assaleh and Firas Kiftaro, "Implementation of Machine Learning Spectrum Sensing For Cognitive Radio Applications", pp. 43-52, 2019, CS & IT-CSCP 2019, In this paper, a cognitive radio system is implemented using National Instruments (NI) Universal Software Radio Peripheral (USRP) devices. The implemented system provides a working prototype based on real data generated and collected by an experimental laboratory setup to compare the performance of spectrum sensing algorithms based on energy detection and polynomial classifier channel sensing techniques. For a sensing time interval ranging from 0.05 ms to 5ms, the experimental results show that the polynomial classifier has a better performance compared to the conventional energy detector in terms of the misclassification rate, especially at lower SNR values.

III Wireless Communication

In modern communication structure, the wireless frequency bandwidth has become recognizable public services. The progression of Frequency band control and determined spectrum allocation are waging a dispute with the spectrum allocation scheme offered based on high demand. The distribution strategies are derived from the static model where the frequency allotment is sought by government agencies around the world, such as the Federal Communication Commission (FCC). This system directs the utilization of the valuable frequency resources which are accessible by the spectrum. The Channel selection practice is playing a significant role to facilitate the cognitive radio along the way to collect the strongest developed channel enclosed by the gathering of recognized channels. The Cognitive Radio Technology should dynamically regulate the parameters of the physical layer, such as frequency, bandwidth, power, etc. After the channel has been allocated to the cognitive radio system, while, if the Primary User arrives, the Cognitive Radio system must suspend its operation and re-allocate the system for an uninterrupted service which steams QoS. The frequent transmission cycle suspensions damage the QoS in the cognitive radio system. Though these works show the QoS requirements, there is still insufficient in the works. Farah.J et al, Tendered the channel allocating channels and resources with the QoS supported to achieve the goal with maximum data rates for all users in cognitive networks, even though this algorithm is highly complex in nature [2].

IV CONCLUSION

The Cognitive Radio Technology is a wireless conceptual communication system which is sensitive to its surrounding environment. In general, it can be expected to pay attention to the parameters such as channel availability, accessible

channels, availability of channels and the nature of data to be transmitted in the forms of modulation which could be used. Cognitive Radio Technology is one of the new longstanding developments going to take place along with the communication systems. The detection of primary user signals is essential for optimum utilization of a spectrum by secondary users in cognitive radio (CR). The conventional spectrum sensing schemes have the problem of missed detection/false alarm, which hampers the proper utilization of spectrum.

REFERENCES:

[1] Aravind Narayanan Krishnamoorthy, Arun Shivaram Pasupathy, Maheshkumar Mani, Santhoshkumar Krishnamurthi, Sathiesh Kumar Leelakrishnan, Kotheneth Achuthan Narayanankutty, "Optimization of Threshold for Energy Based Spectrum Sensing UsingDifferential Evolution", Wireless Engineering and Technology, 2011, 2, 130-134 , doi:10.4236/wet.2011.23019 Published Online July 2011.

[2] R Kaniezhil, "Improvement in Utilization of the Spectrum using Cognitive Radio nodes", International Journal of Computational Intelligence and Informatics, Vol. 4: No. 2, July – September 2014.

[3] Mandeep Kaur,Amandeep Kaur, "Cognitive Radio Spectrum Sharing Techniques : A Review", (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 6 (3) , 2015.

[4] Jamal Elhachmi and Zouhair Guennoun,"Cognitive radio spectrum allocation using genetic algorithm", Elhachmi and Guennoun EURASIP Journal on WirelessCommunications and Networking (2016).

[5] Roopali Garg, Nitin Saluja,"Spectrum Sensing in Cognitive Radio: Components and Methodologies", Proceedings of the World Congress on Engineering and Computer Science 2016 Vol I WCECS 2016, October 19-21, 2016.

[6] Roopali Garg, Dr. Nitin Saluja, "Current Trends and Research Challenges in Spectrum Sensing for Cognitive Radios", (IJACSA) International Journal of Advanced Computer Science and Applications, Vol. 7, No. 7, 2016.

[7] Wei Liang, Soon Xin Ng,Lajos Hanzo, "Cooperative Overlay Spectrum Access in Cognitive Radio Networks", IEEE COMMUNICATIONS SURVEYS & TUTORIALS, VOL. 19, NO. 3, THIRD QUARTER 2017.

[8] J. Divya lakshmi, Rangaiah. L ,"Cognitive Radio Principles and Spectrum Sensing",International Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249 – 8958, Volume-8 Issue-6, August 2019.

[9] L.Rajesh, M Sivaranjini, "Machine Learning Techniques Based Spectrum Sensing In Crn,INTERNATIONAL JOURNAL OF SCIENTIFIC & TECHNOLOGY RESEARCH VOLUME 8, ISSUE 11, NOVEMBER 2019.

[10] M. Mourad Mabrook, Hussein A. Khalil , Aziza I. Hussein , "Artificial Intelligence Based Cooperative Spectrum SensingAlgorithm for Cognitive Radio Networks", ScienceDirect, Procedia Computer Science 163 (2019).

[11] Mohamed El-Tarhuni, Khaled Assaleh and Firas Kiftaro, "IMPLEMENTATION OF MACHINE LEARNING SPECTRUM SENSING FOR COGNITIVE RADIO APPLICATIONS", pp. 43-52, 2019, CS & IT-CSCP 2019.

[12] Pedram Kheirkhah Sangdeh, Hossein Pirayesh, Adnan Quadri, and Huacheng Zeng,"A Practical Spectrum Sharing Scheme for Cognitive RadioNetworks: Design andExperiments", arXiv:1905.10940V1 [cs.NI] 27 May-2019.

[12] Qingqing Cheng,Diep N. Nguyen,Eryk Dutkiewicz, "Deep Learning Network Based

Spectrum Sensing Methods for OFDM Systems", arXiv:1807.09414v4 [eess.SP] 1 Jan 2019.

[13] Yasmina EL Morabit, Fatiha Mrabti, and El Houssein Abarkan, "Survey of Artificial Intelligence Approaches in Cognitive Radio Networks", J. lnf. Commun. Converg. Eng. 17(1): 21-40, Mar. 2019.

[14] Guilu Wuand Hongyun Chu, "Spectrum Sharing with Vehicular Communication in Cognitive Small-Cell Networks", Hindawi International Journal of Antennas and Propagation, Volume 2020.

[16] Jingting Wangand Bao Liu , "A Brief Review of Machine Learning Algorithms for Cooperative Spectrum Sensing,"Journal of Physics: Conference Series, AICNC 2020 .

[17] K.F Muteba, K Djouani, T.O Olwal, "DeepReinforcement Learning Based Resource Allocation ForNarrowband Cognitive Radio-IoT Systems", ScienceDirect, Procedia Computer Science 175 (2020).

[18] M. Kalpana Devi, K. Umamaheswari, "Modified Artificial Bee Colony with firefly algorithm based spectrum handoff in cognitive radio network", International Journal of Intelligent Networks 1 (2020).

[19] M. Saber , A. El Rharras, R. Saadane, A. Chehri, N. Hakem , H. A. Kharraz, "Spectrum Sensing for Smart Embedded Devices in Cognitive Networks using Machine Learning Algorithms", ScienceDirect, Procedia Computer Science 176 (2020).

[20] Muhammad Sajjad Khan ,Noor Gul ,Junsu Kim , Ijaz Mansoor Qureshi,and Su Min Kim,"A Genetic Algorithm-Based Soft Decision Fusion Scheme in Cognitive IoT Networks with Malicious Users", Hindawi Wireless Communications and Mobile Computing, Volume 2020.

[21] Rajalakshmi, P.Sumathy, " Genetic Algorithm Dependent Qos Aware Adaptive Subcarrier Allocation Scheme in Cognitive Radio Networks", International Journal of Engineering and Advanced Technology (IJEAT), ISSN: 2249 – 8958, Volume-9 Issue-4, April 2020.

Neha Kapse received her Bachelor`s degree in Electronics & comunication, IGEC, Sagar, M.P., in 2018. Currently she is pursuing Master of Technology Degree in Electronics & Comunication (Digital communication) from PCST, (RGPV), Bhopal, Madhya Pradesh India. Her research area include wireless communication.

Mr. **Jitendra Mishra** he is Associate Professor and Head of the Department of Electronics and communication in PCST, Bhopal (RGPV). His received Master of Technology and Bachelor's of engineering respectively in Digital communication from BUIT, Bhopal and from RGPV, Bhopal. He has more than 12 years of teaching experience and publish 55+ papers in International journals, conferences etc. His areas of Interests are Antenna & Wave Propagation, Digital Signal Processing, Wireless Communication, Image Processing etc.